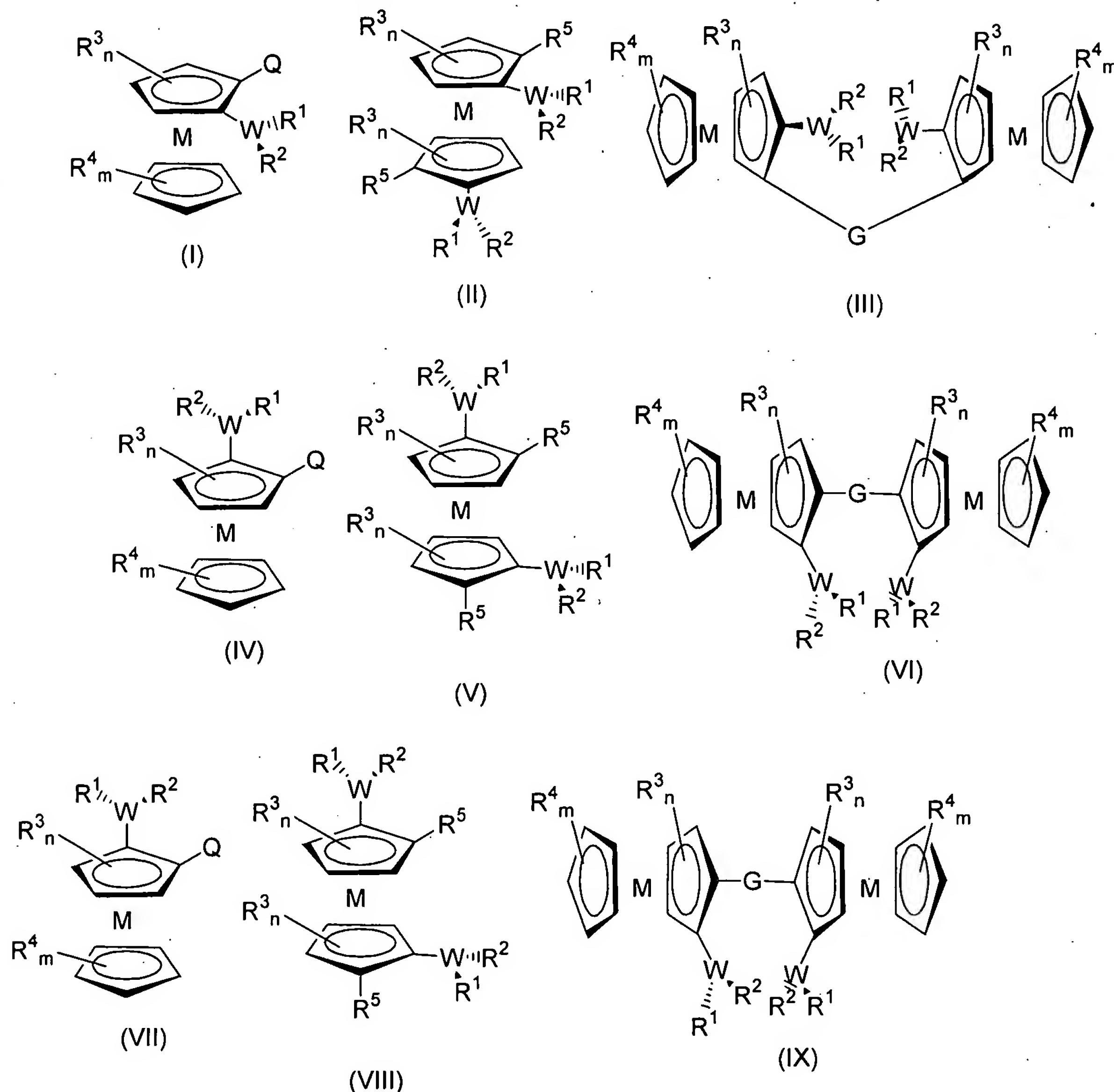


Amendments to the Claims

1-43. (Cancelled)

44. (Currently amended) A metallocene-based ligand having a formula selected from the group consisting of Formula (I), Formula (II), Formula (III), Formula (IV), Formula (V), Formula (VI), Formula (VII), Formula (VIII), and Formula (IX):



wherein

W is phosphorus or arsenic;

M is a metal;

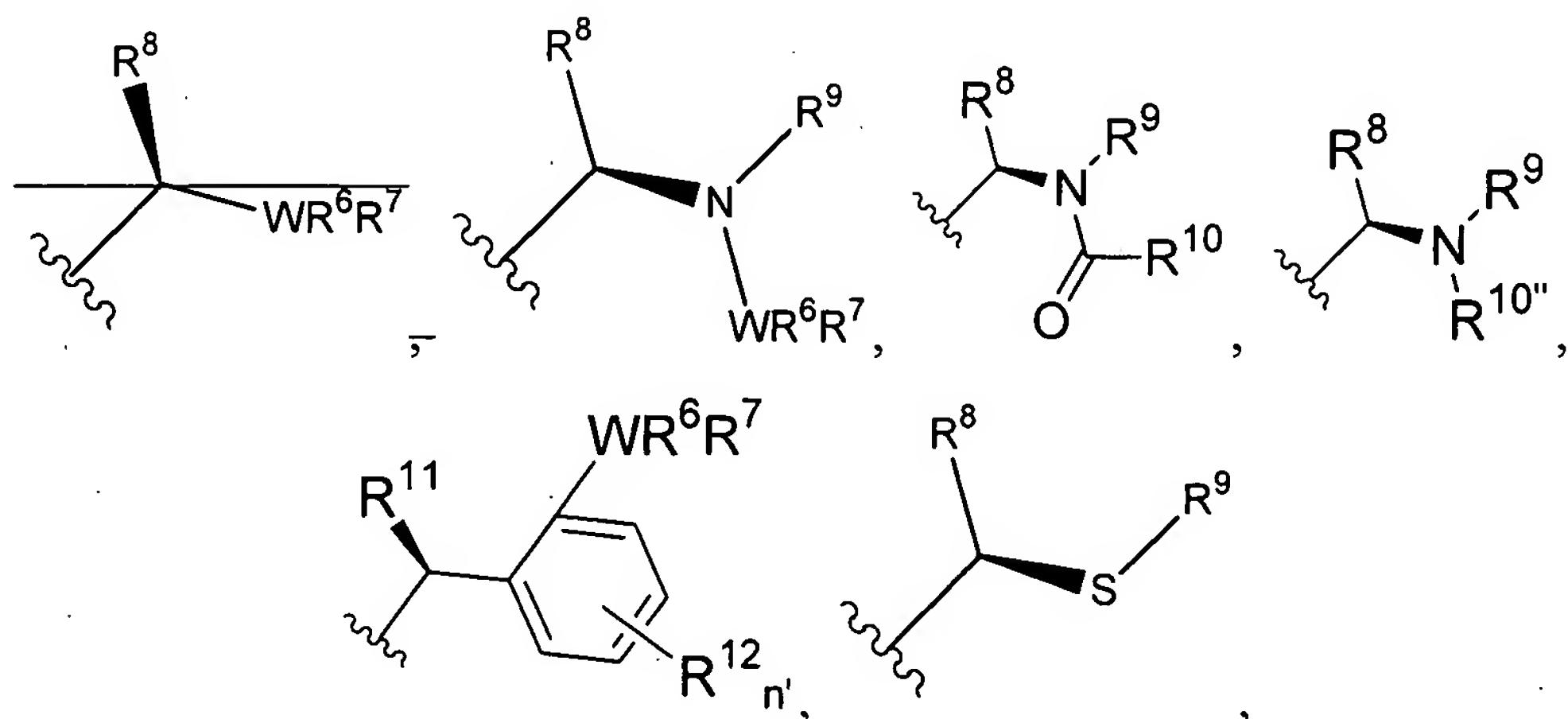
R¹ and R² are different from each other and are independently selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroarylamino;

R³ and R⁴ are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl;

n is an integer from 0 to 3;

m is an integer from 0 to 5;

Q is selected from the group consisting of



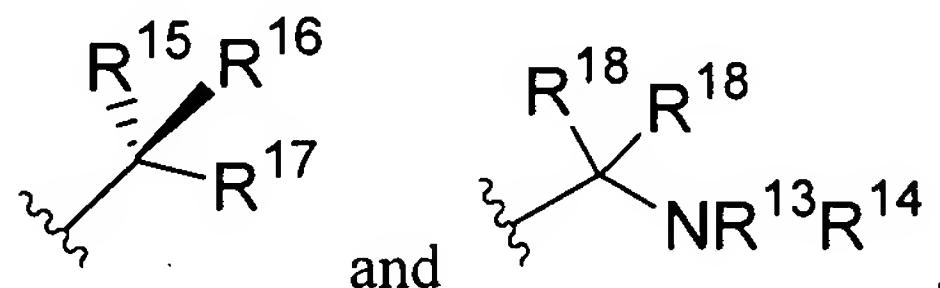
wherein

R^6 and R^7 are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, substituted heteroaryl amino, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, and unsubstituted heteroaryl amino;

R^8 , R^9 , R^{10} and $R^{10''}$ are independently selected from the group consisting of hydrogen, substituted straight-chain alkyl, unsubstituted straight-chain alkyl, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; R^{11} is selected from the group consisting of OR^{13} , SR^{13} , NHR^{13} , and $NR^{13}R^{14}$, wherein

R^{13} and R^{14} are independently selected from the group consisting substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; R^{12} is selected from the group consisting of hydrogen, halogen, OR^{13} , SR^{13} , $NR^{13}R^{14}$, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl, and n' is 0 to 4;

R^5 is selected from:

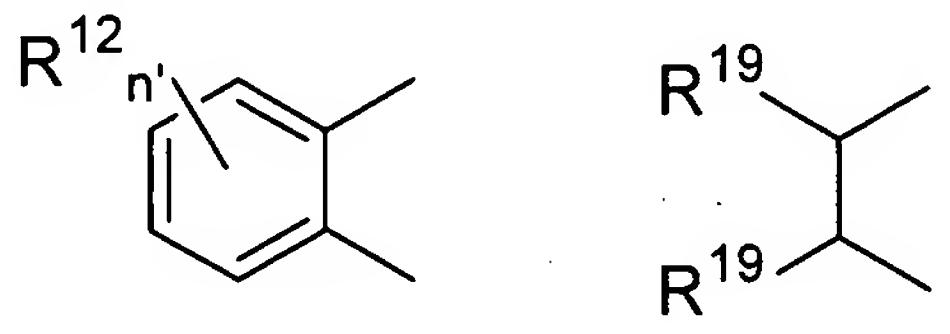


wherein R^{15} , R^{16} and R^{17} are independently selected from the group consisting of hydrogen, halogen, OR^{13} , SR^{13} , $NR^{13}R^{14}$, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; and wherein the two

geminal substituents R¹⁸ together are a doubly bonded oxygen atom, or each substituent R¹⁸ is individually hydrogen; and G is selected from the group consisting of -C(=O)NH-R*-NHCO-, -C(=O)-OR*-O-C(=O)-, -C(=O)-R*C(=O)-, -CH=N-R*-N=CH-, -CH₂NH-R*-NHCH₂-, -CH₂NHC(=O)-R*-C(=O)NHCH₂-, -CH(R⁸)NH-R*-NH(CH(R⁸))-, -CH(R⁸)NHC(=O)-R*-C(=O)NHCH(R⁸)-, -C(=O)NH-R-NHC(=O)-, -C(=O)-ORO-C(=O)-, -C(=O)-RC(=O)-, -CH=N-R-N=CH-, -CH₂NH-R-NHCH₂-, -CH₂NHC(=O)-R-C(=O)NHCH₂-, -CH(R⁸)NH-R-NH(CH(R⁸))-, -CH(R⁸)NHC(=O)-R-C(=O)NHCH(R⁸)-;

wherein R⁸ is, independently, as previously defined;

-R*- and -R- are selected from the group consisting of:



wherein R¹² is as previously defined;

wherein the two substituents R¹⁹ together are -(CH₂)_{m'}- or each substituent R¹⁸ is independently selected from the group consisting of hydrogen, substituted branched-chain alkyl, unsubstituted branched-chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; wherein the or each heteroatom is independently selected from sulphur, nitrogen, n' is an integer of from 0 to 4; and m' is an integer of from 1 to 8;

~~with the proviso that for compounds of formula (I), whereby n and m is an integer of 0, the substitution pattern for R¹ and R² does not include the pairings of:~~

~~phenyl-methyl, phenyl-n-butyl, phenyl-tert-butyl, phenyl-3,5-bistrifluoromethylphenyl, phenyl-anthracenyl, and n-butyl-tert-butyl.~~

with the proviso that the following compounds are excluded:

Fe(C₅H₅)(C₅H₃(CH₂NMe₂)(P Ph Me)),

Fe(C₅H₅)(C₅H₃(CHMeNMe₂)(P Ph Me)),

Fe(C₅H₅)(C₅H₃(CHMeNMe₂)(P Ph n-Bu)),

Fe(C₅H₅)(C₅H₃(CHMeNMe₂)(P Ph t-Bu)),

Fe(C₅H₅)(C₅H₃(CHMeNMe₂)(P n-Bu t-Bu)), and
Fe(C₅H₅)(C₅H₃(CHMeNMe₂)(P Ph (3,5-bis(trifluoromethyl)phenyl))).

45. (Currently amended) The metallocene-based ligand of Claim 44, which is a diastereomer/enantiomer having Formula (IV), Formula (V), or Formula (VI).

46. (Previously presented) The metallocene-based ligand of Claim 44, which is an enantiomer having Formula (VII), Formula (VIII), or Formula (IX).

47. (Previously presented) The metallocene-based ligand of Claim 44, wherein the metallocene-based ligand is a phosphine or arsine having chirality at W, and wherein the metallocene-based ligand has at least one additional element of chirality selected from the group consisting of chirality at carbon, and axial chirality.

48. (Previously presented) The metallocene-based ligand of Claim 44, wherein the metallocene-based ligand is a diphosphine or diarsine having chirality at W, and wherein the metallocene-based ligand has two additional elements of chirality comprising chirality at carbon, and axial chirality.

49. (Previously presented) The metallocene-based ligand of Claim 44, wherein the metallocene is ferrocene.

50. (Currently amended) The metallocene-based ligand of Claim 44, wherein W is phosphorus.

51. (Previously presented) A catalyst or catalyst precursor in an asymmetric transformation reaction to generate a high enantiomeric excess of a formed compound, the catalyst or catalyst precursor comprising the metallocene-based ligand of Claim 44.

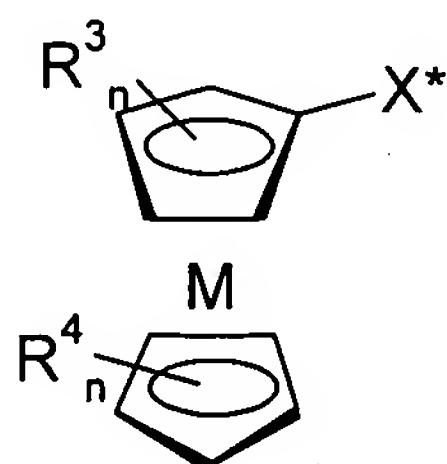
52. (Previously presented) A transition metal complex containing a transition metal coordinated to a ligand according to the metallocene-based ligand of Claim 44.

53. (Previously presented) A transition metal complex according to claim 52, wherein the transition metal is a Group VIb or a Group VIII metal.

54. (Previously presented) A method for preparing the metallocene-based ligand of Claim 44, comprising:

providing a metallocene-based substrate having a chiral directing substituent on one or both rings;
ortho-lithiating the metallocene-based substrate; and
converting the ortho-lithiated metallocene-based substrate to obtain the metallocene-based ligand.

55. (Previously presented) The method according to Claim 54, wherein the metallocene-based ligand has Formula (I) or Formula (III), wherein the metallocene-based substrate has Formula (X'):



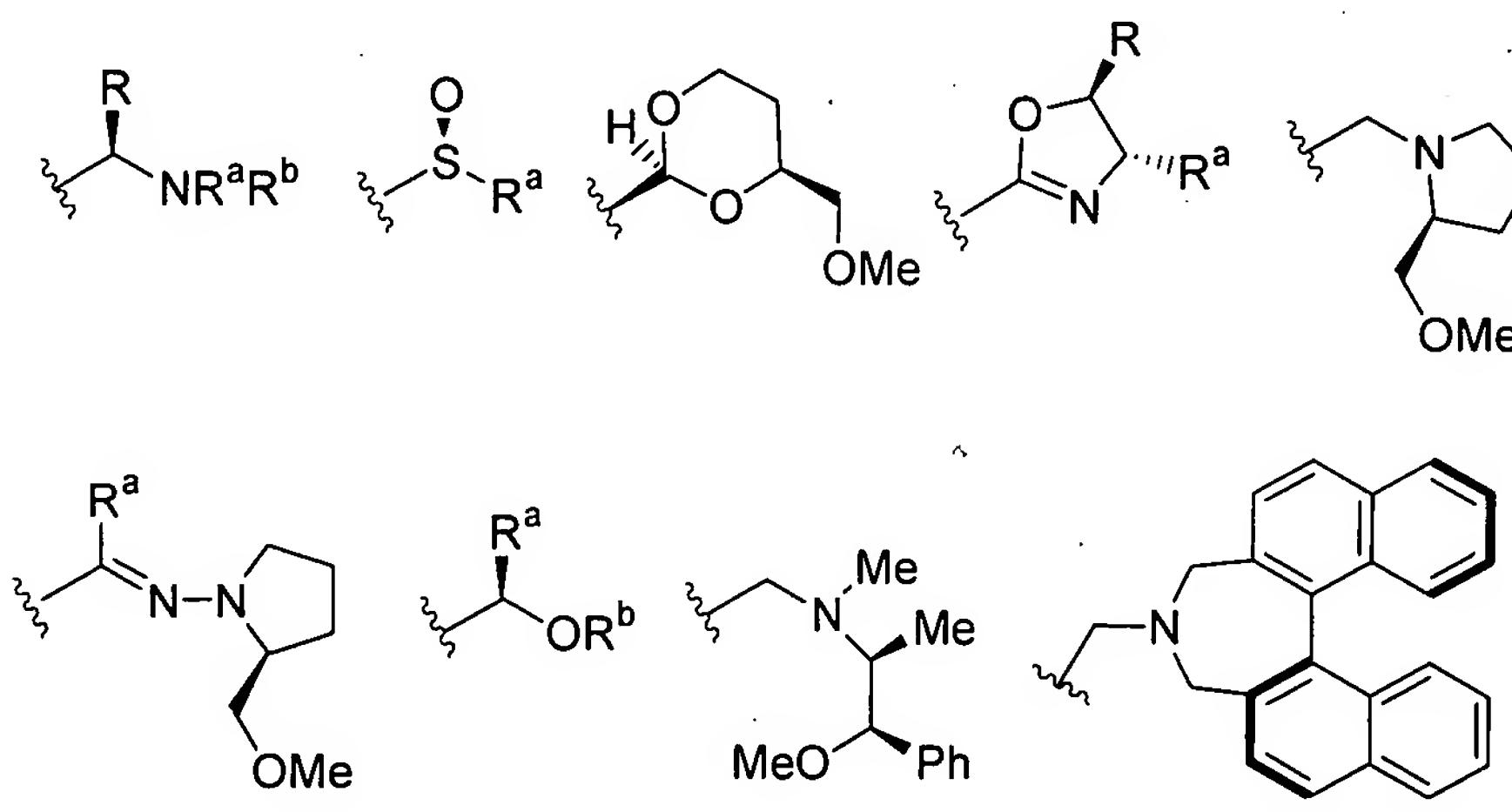
Formula (X')

wherein R³ and R⁴ are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl;

n is an integer from 0 to 3;

and wherein X* is a chiral directing group, wherein the step of converting the ortho-lithiated metallocene-based substrate comprises reacting the ortho-lithiated substrate with an R¹ substituted phosphine or arsine, and with an R²-bearing Grignard reagent or an R²-organolithium compound, then converting X* to Q or G.

56. (Previously presented) A method according to Claim 55, wherein X* is selected from the group consisting of:



wherein

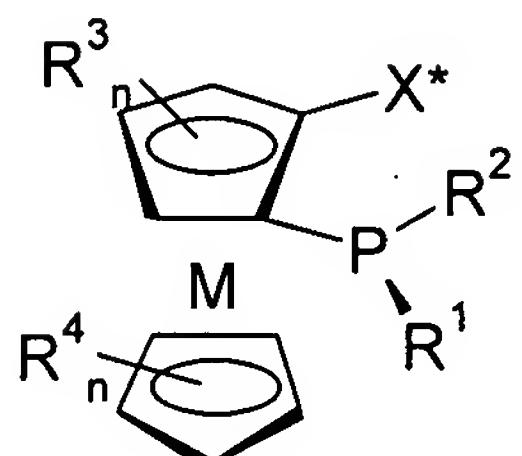
R^a and R^b are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl.

57. (Previously presented) The method according to claim 55, wherein the ortho-lithiation step is conducted using at least one lithiating agent selected from the group consisting of n-butyllithium, sec-butyllithium, and tert-butyllithium.

58. (Previously presented) The method according to claim 57, wherein the step of converting the ortho-lithiated metallocene-based substrate comprises reacting the ortho-lithiated metallocene-based substrate *in situ* with a dichlorophosphine of the formula R^1PCl_2 wherein R^1 is selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroaryl amino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroaryl amino;
to yield an intermediate product, wherein the intermediate product is converted to obtain the metallocene-based ligand.

59. (Previously presented) The method according to Claim 58, further comprising reacting the intermediate product with an organometallic reagent of formula R^2Z , wherein R^2 is selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroaryl amino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroaryl amino;

wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having formula (XI'):



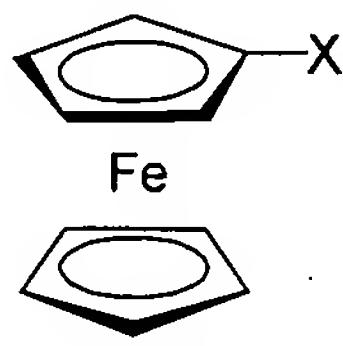
Formula (XI')

wherein the phosphorous chiral compound is converted to obtain the metallocene-based ligand.

60. (Previously presented) The method of Claim 59, wherein the metallocene-based ligand has Formula (I) or Formula (III).

61. (Previously presented) A method for preparing a metallocene-based ligand of Claim 44, comprising:

providing a compound of Formula (XXXVII):



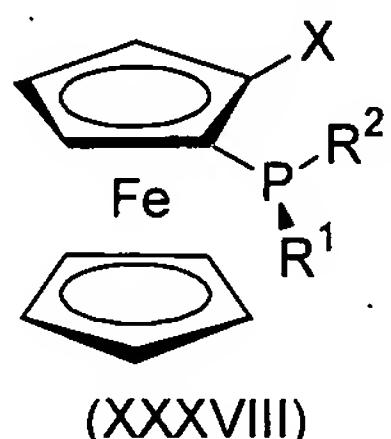
(XXXVII)

wherein X is an achiral directing group;

subjecting the compound of Formula (XXXVII) to enantioselective mono-ortho-lithiation using at least one lithiating agent selected from the group consisting of n-butyllithium, sec-butyllithium, and tert- butyllithium, wherein the mono-ortho-lithiation is conducted in the presence of a homochiral tertiary amine, whereby a chiral monolithium compound is obtained; reacting the chiral monolithium compound *in situ* with a dichlorophosphine of the formula R^1PCl_2 followed by reacting with an organometallic reagent of the formula R^2Z , wherein R^1 and R^2 are different from each other and are independently selected from the group consisting of

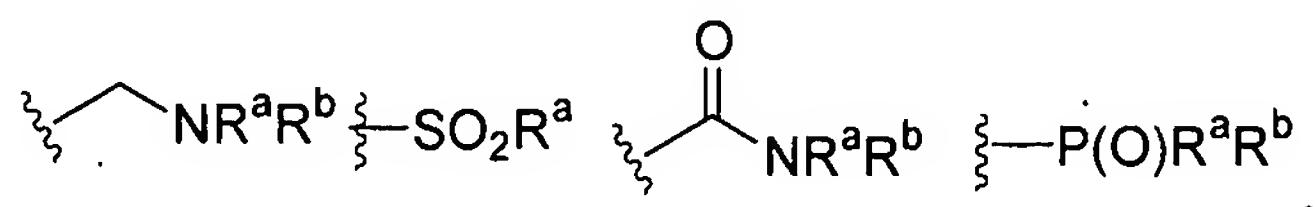
unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroarylamino;

wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having Formula (XXXVIII):



and converting the phosphorus chiral compound having Formula (XXXVIII) to the metallocene-based ligand, wherein the metallocene-based ligand has Formula (I) or Formula (III).

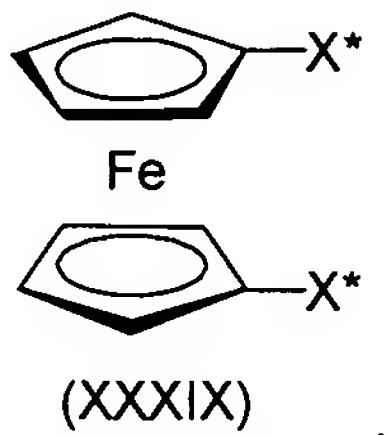
62. (Previously presented) The method according to Claim 61, wherein X is selected from the group consisting of:



wherein R^a and R^b are independently selected from the group consisting of substituted branched-chain alkyl, substituted straight-chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl.

63. (Previously presented) A method for preparing a metallocene-based ligand of Claim 44, comprising:

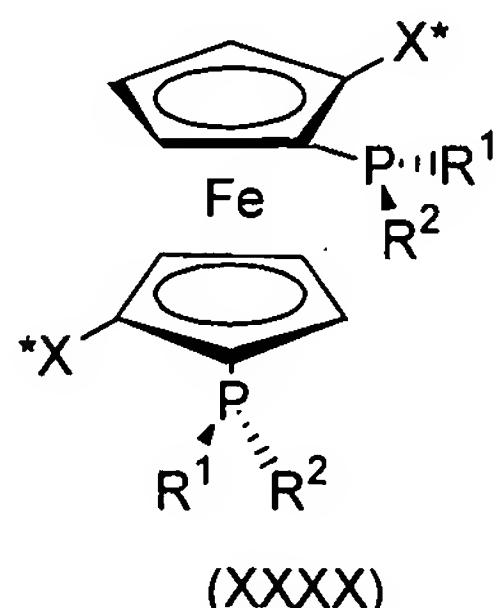
providing a compound of the Formula (XXXIX):



wherein X* is a chiral directing group;

subjecting the compound of Formula (XXXIX) to bis-ortho-lithiation using at least one lithiating agent selected from the group consisting of n-butyllithium, sec-butyllithium, and tert-butyllithium, whereby a bislithium compound *in situ* with a dichlorophosphine of the formula R¹PCl₂ followed by reacting with an organometallic reagent of the formula R²Z wherein R¹ and R² are different from each other and are independently selected from the group consisting of unsubstituted branched-chain alkyl, unsubstituted straight-chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, substituted branched-chain alkyl, substituted straight-chain alkyl, substituted alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, and substituted heteroarylamino;

wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having Formula (XXXX):



and converting the phosphorous chiral compound having Formula (XXXX) to the metallocene-based ligand, wherein the metallocene-based ligand has Formula (II).